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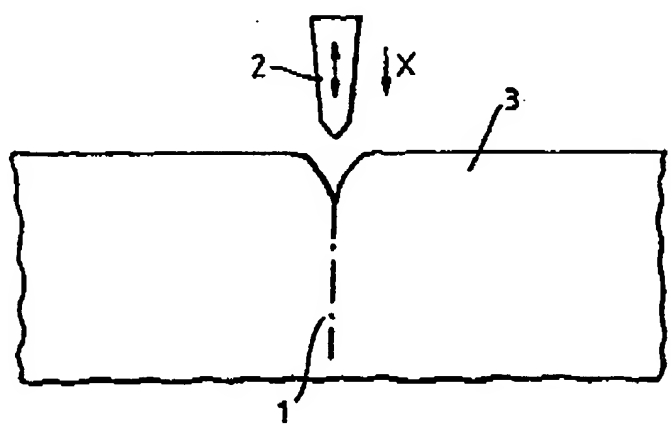
(54) Title: ULTRASONIC CUTTING PROCESS

(57) Abstract

A process for cutting food products (3), especially brittle food products such as frozen fish. The process involves mounting a cutting blade (2) on an ultrasonic system in a manner such that the blade (2) is vibrated parallel to the cut face and the aspect of travel of ultrasound down the blade (2) is approximately 90° to the cutting edge of the blade (2). The cutting blade (2) has a significantly blunted tip. The cutting is effected, at least in part, by localized heating of the food product (3). The process permits cutting of brittle food products into portions with minimum wastage. Fracturing is also reduced thus allowing the portion size to be accurately controlled and providing a final portion having smooth surfaces.



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ULTRASONIC CUTTING PROCESS.

Technical Field of the Invention

This invention relates to a process for cutting food products, in particular brittle food products such as frozen fish.

Background to the Invention

It is highly desirable to be able to cut frozen fish into portions with a minimum loss of fish material. However, it is essential that any cutting technique used must enable the portion size being produced to be accurately controllable. This is not possible if the cutting process results in fractures being present in the food material. Furthermore the cutting technique chosen must provide a smooth surface such that the final portion can be readily battered and crumbed.

FR 2 620 071 (Mecasonic) discloses a method of ultrasonically cutting frozen food material, especially cakes, into portions in their mould. Preferably the blade is knife-shaped and has a cutting angle of 30 degrees. However, we have demonstrated that although such cutting techniques are suitable for cakes and pies, it is not a suitable technique for cutting brittle materials, such as frozen fish, because fractures result. Furthermore the blade life is very short.

EP 353 415 (Nestle) recognises the problem of cutting brittle materials and states that it is not possible to cut brittle material by conventional ultrasonic techniques because a fractured cut is achieved.

EP 353 415 solves the problem of cutting brittle materials by providing a method of cutting an article involving

mounting a cutting blade on an ultrasonic vibrating device in a manner such that the blade lies in a plane extending transversely to the longitudinal axis of vibration and moving said blade in said plane through said article.

In this manner the blade moves back and forth transverse to the plane in which it moves through the article, effecting a removal of the material of the article along the line of cut. In other words the blade is flexed perpendicular to the cut face as illustrated in Figure A.

This technique results in an unacceptable loss of food material.

JP 5 228 894 discloses an ultrasonic cutting device where a thin wire or blade is vibrated ultrasonically along its longest dimension. In practice this sets up a transverse vibration causing the blade to flex perpendicular to the cut surface. Furthermore the aspect of travel of the ultrasound down the blade is parallel to the cutting edge of the blade. This system has been shown to result in a rapid fatigue of the blade and may result in unacceptable loss of food material.

GB 2087290 discloses apparatus comprising a cutting tool for cutting sheet material spread on a support surface; the cutting tool is ultrasonically vibrated along an axis generally perpendicular to the support surface; this causes the sheet material to be severed by a crushing action as it is ultrasonically squeezed between the cutting surface of the cutting tool and the support surface.

The apparatus of GB 2087290 is not suitable for cutting brittle food substances since its crushing action results in fractures being formed. Furthermore, frozen fish blocks, for example, are generally too thick for the cutting tool to sever without substantial fractures forming.

Therefore, to date, it has not been possible to provide a process for cutting brittle food substances without loss of food and without forming fractures.

We have now solved this problem by use of ultrasonic cutting whereby the blade has a significantly blunted tip, the blade is vibrated parallel to the cut face as illustrated in Figure 1 and the aspect of travel of ultrasound down the blade is approximately 90° to the cutting edge of the blade. As a result, the cutting of the food product is effected, at least in part, by localised heating of the food product.

Description of the Invention

Accordingly, the invention relates to a process for cutting food products involving mounting a cutting blade on an ultrasonic system in a manner such that the blade is vibrated parallel to the cut face and the aspect of travel of ultrasound down the blade is approximately 90° to the cutting edge of the blade; wherein the cutting blade has a significantly blunted tip; and wherein the cutting is effected, at least in part, by localised heating of the food product.

By significantly blunted is meant that the tip of a traditional knife-shaped blade, as illustrated by Figure B, is blunted relative to the cutting angle by either a substantial rounding of the tip or by the provision of a symmetrical or asymmetrical secondary angle of from 45° to 180°. This secondary angle is marked by angle x in figure 3b. A substantial rounding of the tip includes blades having at least a tertiary angle. Suitable blades are illustrated in Figures 3 to 5. Preferably the blade is blunted by provision of a secondary angle of from 60° to 120° or by rounding. Most preferably the blade is blunted by provision of a secondary angle of 90°.

By cutting angle is meant the angle at the tip of the blade prior to any blunting. Preferably the cutting angle of the cutting blade is from 1 to 20 degrees, most preferably from 3° to 10°. The cutting angle is marked by angle y in figure 3b.

It is essential that the aspect of travel of ultrasound down the blade is approximately 90° to the cutting edge of the blade, a deviation of up to 10° either side of 90° is tolerable (ie. from 80° to 100°).

The cutting edge may be flat or may comprise teeth-like ridges.

The cutting blade may be of any length providing that the total length of the blade is a multiple of 0.5 of a wavelength. The length W of the blade is shown in Figure 2.

The cutting of the food product is effected, inter alia, by localised heating at or close to the cut face and by the slicing action of the blade. The heat may result from internal damping eg. damping of the vibrational energy, or internal resistance eg. friction between the blade and the food product. The ultrasound concentrates heat at or close to the cut face.

The ultrasonic system may be any conventional system and will typically comprise a press and a vibrating acoustic element consisting of an emitter, an amplifier and a sonotrode supplied by a high-frequency generator.

In one embodiment, the blade cuts and passes through the static article to be cut. In another embodiment, the article is cut by moving it towards the static, angled blade.

The blade may be vibrated at a frequency of between 18kHz and 50kHz.

Preferably, the blade can cut articles which are up to 100mm thick.

Preferably the food product to be cut is at a temperature of from -5°C to -25°C, most preferably from -8°C to -15°C.

The food product may be frozen meat or poultry; preferably the food product is frozen fish.

In the accompanying drawings Figures A & B are comparative illustrations whereas Figures 1-5 illustrate the invention;

Figure A is a schematic view showing a cutting system in which the blade is flexed perpendicular to the cut face as, for example, in EP 353 415.

Figure B is a cross-section of a conventional knife-shaped blade tip having a cutting angle of 30°.

Figure 1 is a schematic view showing a cutting system in which the blade is flexed parallel to the cut face.

Figure 2 is a side elevation of the cutting blade, where the cutting edge is labelled 5.

Figures 3 to 5 are cross-sections along the line Y-Y marked in Figure 2 showing different types of significantly blunted blade tips;

Figures 3a & 3b have a cutting angle y of 10° and a secondary angle x of 90°.

Figure 4 has a cutting angle of 10° and a rounded tip.

Figure 5 has a cutting angle of 10° and a secondary angle of 180°.

Figure 6 is a perspective, schematic view of a cutting system in which the article is moved towards the static blade.

In Figure A a blade 2 is vibrated at an ultrasonic frequency perpendicular to the cut face 1 as illustrated by the directional arrows A <---> B, and on passage through the article 3 to be cut will excavate a cut 4 from the article, as the blade passes through the article in the direction X.

In Figure 1 a blade 2 is vibrated at an ultrasonic frequency parallel to the cut face 1, and the blade passes through the article 3 to be cut in the direction X.

In Figure 6, a static, angled blade 2 is vibrated at ultrasonic frequency parallel to the cut face 1, and the article 3 is moved in direction Z towards the blade.

Example 1

A frozen fish plank (-15°C) of depth 22mm and width 85mm was ultrasonically cut into strips with blades of the form shown in Figures 3a and 3b (cutting angle 10°; secondary angle 90°). Two blade materials were tested one being an Aluminium Alloy and the other a Titanium alloy.

For both blades the cutting speed was 6mms^{-1} and after completing an experimental matrix of up to 1000 cuts the cutting edge was still in good condition.

The maximum cutting force at the velocity of 6mms^{-1} was approximately 16% of the load when the ultrasonics were turned off. The cutting losses were approximately 10% of

those achieved with a bandsaw and the cut surfaces were smooth.

Example 2

A frozen fish block (-15°C) of depth 65mm and width 60mm was ultrasonically cut with blocks of the form shown in Fig. 3a and 3b. Titanium and alluminium alloys were used in the manufacture of the blades. After a matrix of experiments involving speed of blade of up to approximately 300 cuts the cutting edge was still in good condition. The maximum cutting force at a velocity of $6mms^{-1}$ was approximately 20% of that obtained with the ultrasonics off.

Example 3

A frozen fish block (-10°C) of depth 22mm and width 85mm was ultrasonically cut into strips with a Titanium Alloy blade of the form shown in Figures 3a and 3b (cutting angle 10°; secondary angle 90°).

For this blade the maximum cutting force at the velocity of $25mms^{-1}$ was 0.3KN, and portions of good shape with a smooth cut surface were obtained.

The maximum cutting force at a velocity of $25mm^{-1}$ was approximately 35% of that obtained with the ultrasonics off.

Comparative Example A

A frozen fish block (-15°C) of depth 65mm and width 60mm was cut ultrasonically with a blade of the form shown in Figure B (knife-shaped blade with a cutting angle of 30°). The blade was made of Aluminium alloy. The cutting speed was approximately $5mms^{-1}$ and during preliminary trials the blade became damaged. The damage took the form of bending and

fracture of the tip section of the blade.

Comparative Example B

Comparative Example A was repeated except that the blade was made of a Titanium alloy, was knife-shaped and had a cutting angle of 10°.

The blade was again damaged.

Claims

1. A process for cutting food products involving mounting a cutting blade on an ultrasonic system in a manner such that the blade is vibrated parallel to the cut face and the aspect of travel of ultrasound down the blade is approximately 90° to the cutting edge of the blade; wherein the cutting blade has a significantly blunted tip; and wherein the cutting is effected, at least in part, by localised heating of the food product.

2. A process according to claim 1 wherein the cutting angle of the blade is from 1° to 20°.

3. A process according to claim 1 or 2 wherein the cutting angle of the blade is from 3° to 10°.

4. A process according to any preceding claim wherein the blade tip is significantly blunted by either a substantial rounding of the tip or by the provision of a symmetrical or asymmetrical secondary angle of from 45° to 180°.

5. A process according to any preceding claim wherein the blade tip is significantly blunted by either a substantial rounding of the tip or by the provision of a symmetrical or asymmetrical secondary angle of from 60° to 120°.

6. A process according to any preceding claim wherein the blade tip is significantly blunted by the provision of a secondary angle of 90°.

7. A process according to any preceding claim wherein the temperature of the food product to be cut is from -5°C to -25°C.

8. A process according to any preceding claim wherein the temperature of the food product to be cut is from -8°C to

-15°C.

9. A process according to any preceding claim wherein the food product is frozen fish, meat or poultry.

Fig.A.

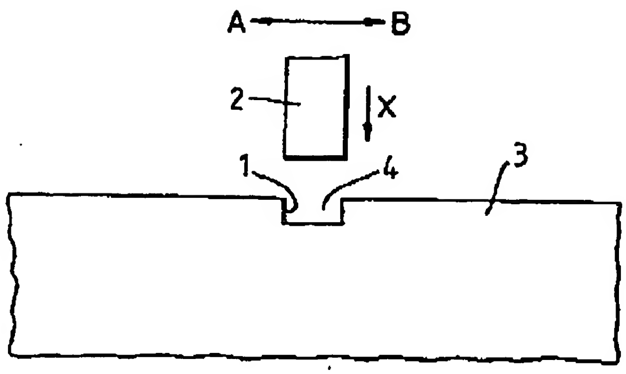


Fig.1.

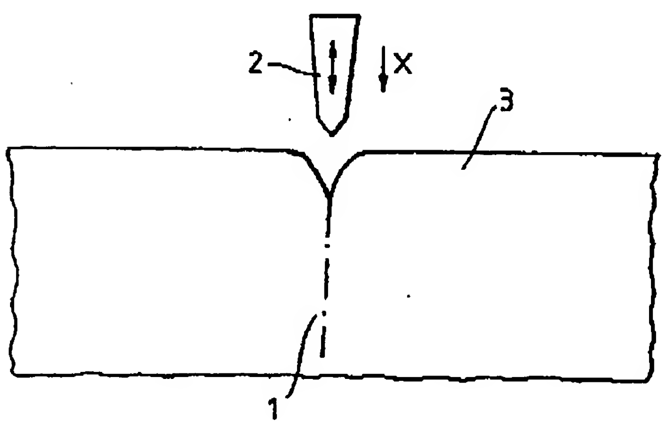


Fig.2.

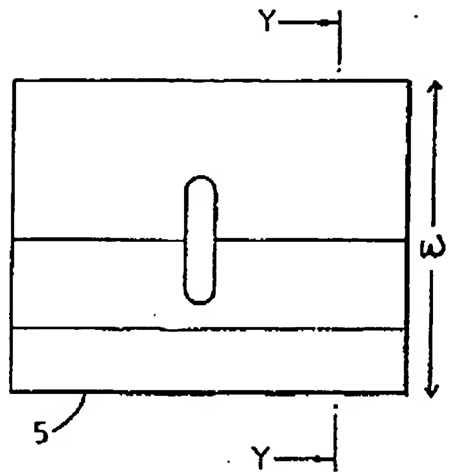


Fig.B.

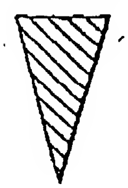


Fig.3a.

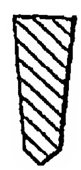


Fig.3b.

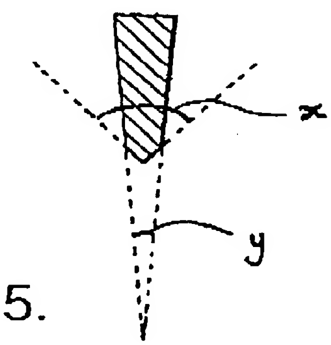


Fig.4.

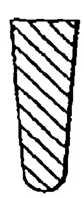
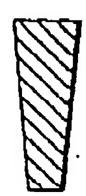


Fig.5.



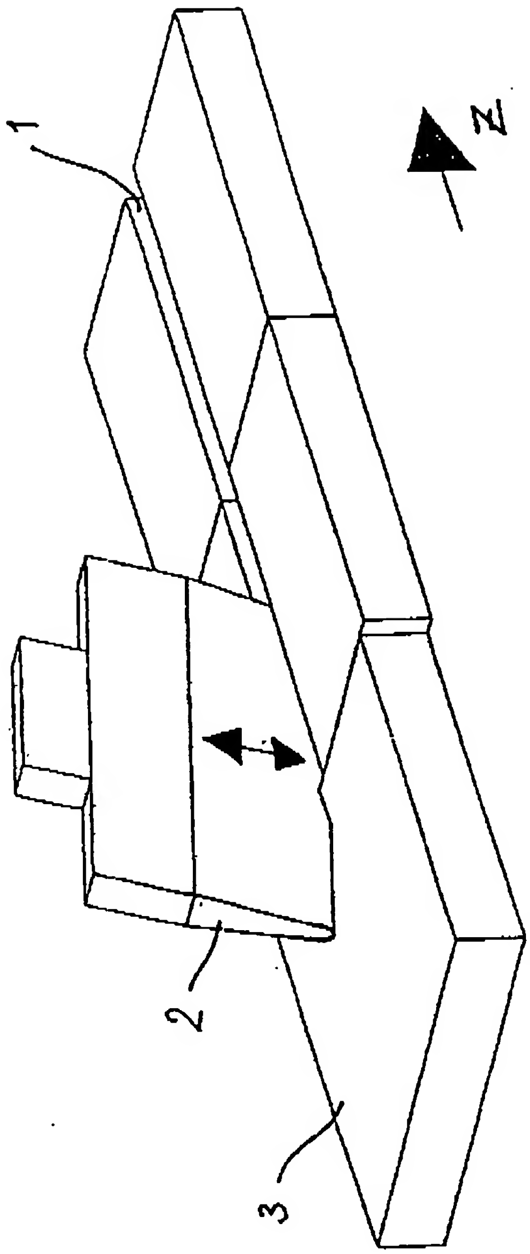


Fig.6.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 95/03812

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B26D1/00 B26D7/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B26D B28D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE,A,25 04 019 (KARL JAUS & SOHNE) 19 August 1976 see page 8, paragraph 2; figures	1
X	GB,A,2 087 290 (GERBER GARMENT TECHNOLOGY) 26 May 1982	1
Y	see page 3, line 11 - line 96; figures 7-17	2
A		4-6
Y	DE,A,42 32 187 (DU PONT DE NEMOURS (DEUTSCHLAND GMBH) 31 March 1994 see column 6, line 43; figure 3	2
A	EP,A,0 243 981 (RAUMA-REPOLA OY) 4 November 1987 see page 4, line 20 - line 37; figure 10	2,3

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[X] Further documents are listed in the continuation of box C.

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24 January 1996	19.02.1996

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,2 361 288 (HARDY) 24 October 1944 see page 1, right column, line 28 - line 33; figure 2	5,6
Y	DE,A,27 43 258 (AGUISAGE SERVICE S.A.) 29 March 1979 see page 4, paragraph 4; figure	2
A	FR,A,2 620 071 (MECASONIC S.A.) 10 March 1989 cited in the application see abstract	7,8
A	EP,A,0 543 628 (UNILEVER P.L.C.) 26 May 1993 see page 2, line 13 - line 21	7,8
A	DATABASE WPI Week 9340 Derwent Publications Ltd., London, GB; AN 93-316989(40) & JP,A,05 228 894 (SOZO KAGAKU KK) , 7 September 1993 cited in the application see abstract	1,9
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 95/03812

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-A-2504019	19-08-76	NONE		
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